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ABSTRACT

This project trained 52 severely handicapped children (ages 3-12) on communication skills using microprocessor technology. Data analyses showed discernible effect of the additional computer training when compared to regular classroom communication training alone. Effects were strongest on a direct criterion-referenced measure of vocabulary taught. A cluster of more general language measures taken by the researchers, classroom teachers, and parents also detected significant benefits to the computer enhancement condition. Benefits of this training were also notable on teacher and parent measures of social interaction skills. (PB)

FINAL PROJECT REPORT

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Using Microprocessors to Develop Communication Skills in Young Severely Handicapped Children

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Certification: I certify that the best of my knowledge and belief this report (consisting of this and subsequent pages and attachments) is correct and complete in all respects.

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Using Microprocessors to Develop Communication Skills

In Young Severely Handicapped Children

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SUMMARY: This research project trained 52 severely handicapped children on communication skills using microprocessor technology. Data analyses showed discernible effect of the additional computer training when compared to regular classroom communication training alone. Effects were strongest on a direct criterion-referenced measure of the vocabulary taught. A cluster of more general language measures taken by the researchers, classroom teachers, and parents also detected significant benefit to the computer enhancement condition. The benefit of this training was even discernible on teacher and parent measures of social interaction skills.

PROJECT OBJECTIVES REPORT: Table 1, Work Breakdown Structure, lists the twelve major objectives of the study, along with major targeted activities and tasks. All twelve objectives of the project were met, pretty much in the order outlined. The one activity that was not possible was # 3.3, behavioral observations in the classroom. The orginally proposed Initial Communication Processes Scales (CTB McGraw Hill, 1982) did not include behaviors at a high enough level to capture the abilities of the highest level students in the study. Although researchers did observe informally all subjects in their classrooms on a regular basis, no formal system was utilized. A search of existing observational coding schemes turned up none that was sufficiently broad in scope to include the wide range of subject skills in social communication with reliable and valid procedures. The time pressures of beginning data collection did not allow for the adequate development of our own scheme to assure reliability. Therefore, the social communication of students was judged by the classroom version of the Vineland Social Maturity Scale, utilizing teacher ratings.

A time extension of six months was requested because final follow-up data collection for the retention of learned criterion vocabulary was not complete until the end of Sept er, 1988. Only at that point could the data coding, reduction and analysis begin. The project ran into delays in providing the appropriate number of training sessions to some subjects who were ill or out of town. Working with five different school sites, served by four graduate student research assistants, made scheduling a "challenge". Each school had its own set of constraints on when

and where the students involved in the research project could be seen. This sometimes resulted in very inefficient use of project staff time. A very few subject parents were not able to be located for final interviews and ratings. However, in general, parents of the children were extremely cooperative and interested in participating; the attrition of subjects over the 8 months of the project was only two (3.7%).

The following section will summarize the actual procedures and research outcomes of the study:

SUBJECTS: The 52 children serving as subjects were enrolled in five school-based programs operated by the Los Angeles County Superintendent of Schools Office of Special Education. These classes were housed within a radius of 15 miles from one another in the San Gabriel Valley of greater Los Angeles. All children at these five schools who met the following criteria were included in the study:

- developmental age of at least 15 months
- grossly intact vision and hearing so that computer stimuli could be processed
- upper body motor control sufficient to allow child to press expanded keyboard keys
- behavior under sufficient control that child could work individually with graduate student for periods of 15 to 30 minutes
- using no more than single words or signs to communicate and considered by teaching staff to be significantly delayed in communication compared to peers
- parents provided informed consent for the procedures

Twenty-eight of the children attended two schools for severely handicapped children at segregated campuses. Twenty-four of the children were in severely handicapped classrooms housed at three regular elementary schools for the purpose of potential integration. Average chronological age was 71.4 months (5.9 years) with a range from 40 months (3.3 years) to 155 months (12.9 years). Developmental age was assessed by two licensed school psychologists who were highly familiar with this population using the Piagetian Ordinal Scales of Development, Cognitive Scale, (Foreworks, 1983). Mean developmental age was 24.5 months, with a range from 12 to 58 months. Primary diagnoses included retardation (unspecified etiology and Down syndrome), severe emotional disorder (including autism), severe specific language disorder, cerebral palsy, and multiple handicaps. Twenty-four of the 52 children had secondary handicaps. Table 2 summarizes the characteristics of the children in each of the two treatment groups. There were no statistically significant differences between the two groups on any of these variables.

PROCEDURE: Children were assigned to one of two treatment phases of 10 weeks' duration. Random assignment was possible at three schools. Because of logistics of transport and storage of

the microprocessor, as well as scheduling of space for training at the two remaining school sites, children enrolled in one of these programs were seen during treatment phase 1 and those enrolled in the second were seen during phase 2. Children were enrolled in these schools based solely on geography. All subjects were pretested on a standard battery of communication and communication-related measures (see Table 3) within one month prior to the start of treatment. The half of the subjects assigned to treatment phase 1 were then seen over the next 10 weeks for a total of 16 individual training sessions. A graduate student in Communication Disorders worked with each child utilizing the PEAL software (Programs for Early Acquisiton of Language, Meyers, 1986). The sessions were scheduled to be 30 minutes long, but some had to be curtailed due to unforseen events at the school or because of the child's cooperation and attentional limits. Actual mean total time of training (in minutes) is reported in Table 2 (maximum = 480). During treatment Phase 1, subjects assigned to treatment Phase 2 received their regular classroom instruction which included communication training by the classroom teacher, although no standard curriculum was used. Midpoint testing consisted of repeating all measures from the baseline pretests for <u>all</u> subjects, regardless of whether they received the computer training or not. During phase 2 of the treatment, the second half of the subjects were seen for 16 sessions over 10 weeks while the subjects in phase 1 now received only the regular classroom program for communication training. Posttesting was carried out for <u>all</u> subjects once again on all measures of communication behavior. This was done within one month of the completion of all training.

DESIGN AND RESULTS: A one-way analysis of covariance design was used with the baseline measures of the dependent variables co-varied out of the analyses in order to enhance statistical power. In essence, this highlights the effects of treatment by allowing the assumption that all subjects began at the same level on the covariate rather than at different levels. Chronological age and developmental age were considered as additional co-variates, but were dropped since they did not add effects above the dependent variable scores. Since this was a small subject study, clustering of individual dependent variables into several conceptually-related composite variables allowed more reliablility and reflected the strong overlap among the various measures used in the study. Table 3 lists the measures that were administered in the assessment battery by reporting source (clinician, teacher, parent). Table 4 shows how the individual variables were clustered for statistical analyses into three outcome composites that measured 1) direct training effects of the vocabulary presented in the computer condition 2) general language information, including both receptive and expressive abilities and 3) social/interpersonal skills. These composite variable clusters were determined by conceptual relationships and were verified by intercorrelation matrices and a principal components factor analysis.

Table 5 shows the results of the series of one-way ANCOVAs on the three composite outcome variables. Treatment group A (Phase I training) and treatment group B (Phase II training) are compared on each of the composite variables with baseline values on that composite entered as a covariate. Perhaps not surprisingly, analysis with the PEAL criterion test showed the strongest effect of the computer training. Group A showed a marginally lower ability to recognize the PEAL vocabulary before training. By midpoint testing, they earned scores significantly above Group B. During Phase 2 of the research, the group receiving training (Group B) made significant gains while Group A remained about the same. Follow-up testing showed no difference in their scores once again; both groups had maintained the gains they had made one month after all training stopped. These results clearly indicate that the severely handicapped children in this study were able to profit from direct, individual computer/clinician training to show comprehension of specific vocabulary in pictured format.

Results using the composite language variable show a similar, though less extreme, pattern. At baseline, Groups A and B were not significantly different on the language measures. At midpoint, Group A, who had received the training during Phase 1, tested higher at a alpha criterion of $p = .07$ (traditionally $p = .05$ is the accepted level of significance; however, with small samples a criterion of $p = .10$ is often used). At posttest, there was again no significant difference, e.g. the Phase 2 computer training of Group B had brought them up to the level of Group A. Gain from point to point was upward and positive (and significant) for both groups at both intervals (pre-test to midpoint, and mid-point to post-test). This means that language scores for a wide range of more standard receptive and expressive measures were improving over time for all subjects: they just improved more when the training program was administered.

The final analysis looked at parents' and teachers' ratings of social/interpersonal behaviors in these children. There was no significant difference between the two groups at pre-test. At mid-point testing there was a significant difference ($p = .053$) between the groups with Group A showing effect of the treatment. At post-test, there was no longer a significant difference between the groups, showing that Group B had caught up after delayed training. Gains from pre-test to midpoint and from midpoint to post-test were significant for Group A. For Group B, the gain from pre-test to midpoint (no treatment) was not significant but the gain from mid-point to post-test was.

Overall, this pattern is quite consistent in showing effects of the training not only directly on the trained vocabulary, but more generally on related language measures and even on more indirect measures of social/interpersonal functioning. While the actual magnitude of change over this relatively short 6 month period was not large, the differential effect of direct, microprocessor-based interactive communication training can be clearly documented amd suggests that such applications of technology to the severely handicapped population are worth pursuing actively.

These findings, obtained as they were in actual instructional settings as opposed to laboratory outcomes, have implications for the instructional use of technology in programs for even the most cognitively and phyically impaired children in our schools. Although most of these subjects were incapable of using the computer intervention without supervision and support from a "trainer" (in this case a graduate student), they were able to sustain interest and to respond to the format over a period of at least 10 weeks. In some individual cases, the response was dramatic. One 4 year old with a diagnosis of retardation and autism began to echo words for the first time while on the computer intervention.

One benefit to the training protocol that was commented upon favorably by teachers and parents was the opportunity for significant amounts of one-on-one individual attention. While it would obviously not be cost-effective to have a teacher engaged in this kind of individual instruction on a routine basis, the structure afforded by the program lends itself to the use of paraprofessionals -- or even tutors from among the older or more able students. This could extend the amount of time that these children are receiving interactive, individual attention within the classroom, or even through tutorials provided beyond the formal instructional day. The key, of course, lies in the availablity of appropriate software for this type of student; development of motivating, low-level, interactive software programs is critical. Trainers in this study felt that the presence of the actual physical object that was represented on the screen was very important. Children functioning at this level need concrete examples along with the more abstract representation graphics. To date, there is virtually no other software besides PEAL that provides for this need, although it should be possible for "trainers" to assemble concrete items to accompany selected published software.

The development of communication skills is a critical component of any curriculum for severely handicapped children. To help them better communicate wants, needs, feelings and ideas should be the central mission of education with this population. This research has shown that current microprocessor technology can be utilized in an interactive and concrete manner with severely handicapped youngsters so that their specific vocabulary, and more general language and social skills benefit.

DISSEMINATION

The following presentations of juried papers on the research represented by this grant have been made, or are scheduled for presentation. Early papers presented the preliminary analysis: presentations from April and into November, 1989, include the full data treatment findings:

O'Connor, L. & Schery, T. Using microprocessors to develop communication skills in young severely-handicapped children. C E.C. Special Education Technology Conference, Reno,

Nevada, December, 1988.

Schery, T. & O'Connor, L. Developing communication skills in severely-handicapped children: A computer approach. California Speech & Hearing Association Conference, Los Angeles, CA., April, 1989.

Schery, T. & O'Connor, L. Communication intervention using microprocessors with severely-handicapped children. Society for Research in Child Development. Kansas City, KS. April, 1989.

Schery, T. & O'Connor, L. Assessing effectiveness of computer language intervention with severely handicapped students. American Speech, Language Hearing Assn. Convention, St. Louis, MO., November, 1989.

O'Connor, L. & Schery, T. Computers in classroom: Can they help teach communication skills? Council for Exceptional Children, Montreal, Canada, April, 1990.

In addition, abstracts of research results were sent to the school administrators, psychologists, speech-language pathologists, and special education teachers who had participated in the study. Individual meetings were offered on a school site level to discuss results and implications for use of the computer software and speech synthesizer that were donated to the three cooperating programs from the grant. As of June, 1989, all of the software was in use for instructional purposes.

A journal article is being prepared for submission to a journal with an appropriate readership (Journal of Speech and Hearing Disorders, The Journal of the Association of Severely Handicapped, The Journal of Special Education Technology etc.)

TABLE 1
WORK BREAKDOWN STRUCTURE

Objective	Major Activities	Tasks
1.0 Identify 50 subjects that meet subject criterion at a maximum of three County operated special education sites	1.1 Research site orientation	1.1.1 Arrange for staff meeting at each site
		1.1.2 Prepare outline for presentation
		1.1.3 Prepare handouts for presentation
	1.2 Identification of subjects meeting selection criteria by school staff	1.2.1 Develop summary sheet for teacher use
		1.2.2 Conference with teachers regarding subjects identified
	1.3 Parent permission.	1.3.1 Prepare permission form including brief explanation of project.
		1.3.2 Distribute form to parents
	1.4 Verification of status through record review	1.4.1 Review student records to ascertain information regarding vision and hearing abilities, as well as prior developmental testing.
		1.4.2 Arrange for needed vision and hearing testing
	1.5 Additional Piagetian and developmental baseline assessment	1.5.1 Psychologist develops schedule for assessment of subjects selected.
		1.5.2 Psychologist administers tests
		1.5.3 Psychologist reports results to investigators

Objective	Major Activities	Tasks
2.0 Train three graduate research assistants to within an 85% interrater reliability in judging baseline communication assessments and in administration of experimental program. a) on formal communication instruments b) on parent/teacher interview formats c) on behavioral classroom observation d) on administration of computer intervention	2.1 Reliability training for formal communication assessments	2.1.1 Observe sample administration and scoring of each GRA for standardized procedures. 2.1.2 Compare scoring and interpretation
	2.2 Reliability training for parent/teacher interview formats	2.2.1 Present standard interview and adaptations. 2.2.2 Observe sample interview 2.2.3 GRAs score sample interview and comparison of scores on project protocols made.
	2.3 Reliability training for behavioral observation in classroom	2.3.1 Presentation of forms and training session for forms to be utilized, as well as description of behaviors with the sampling procedures. 2.3.2 Score sample video tape and compare coding of protocols to a .85 reliability.
	2.4 Training for program administration	2.4.1 Demonstration of software and its use with children 2.4.2 Student research assistants practice program administration with non-subject children 2.4.3 Investigators observe students administering the program
3.0 Gather functional baseline information on subjects' communication functioning	3.1 Formal communication assessments	3.1.1 GRAs administer formal tests 3.1.2 Score tests and record results
	3.2 Parent and teacher interviews	3.2.1 GRAs administer Vineland Behavior Rating Scale - Survey form to parents, including supplemental questions (see Appendix C) 3.2.2 GRAs conduct teacher interviews to determine classroom functioning.

Objective	Major Activities	Tasks
	3.3 Behavioral observation in classroom	3.3.1 GRAs observe each subject in his or her classroom and record desired behaviors using project protocols.
4.0 Implemnt computer intervention for randomly selected one-half of subjects (Phase I)	4.1 Yoking (pairing) subjects with similar profiles	4.1.1 Using age, sex, socio-economic status and other pertinent baseline information, subjects at each research site will be paired for treatment.
	4.2 Designate treatment/no treatment conditions for subject pairs.	4.2.1 Using random selection one member of each pair will be assigned to Phase I and the other to Phase II
	4.3 Run computer communication intervention with one-half of subjects	4.3.1 Each subject will receive 20 sessions within 8 weeks, with an average of 3 sessions per week.
5.0 Re-assess all subjects at completion of Phase I of intervention	5.1 Communication assessments	5.1.1 Re-administer vocabulary measures
		5.1.2 Score tests and record results
	5.2 Parent and teacher interviews	5.2.1 Using Vineland Behavior Rating Scales and protocols marked Appendix C, current communication behaviors in the home will be determined.
		5.2.2 Using ICP, current classroom functioning will be determined.
		5.2.3 Results of interviews appropriately recorded.
	5.3 Behavioral observation in classroom	5.3.1 Same as 3.3.1
6.0 Consider preliminary results of Phase I intervention	6.1 Data analysis of Phase I intervention	6.1.1 Transfer summary scores for all assessments to appropriate summary sheets.

Objective	Major Activities	Tasks
		6.1.2 Summarize data by individual subject
		6.1.3 Construct visual displays of growth rates.
		6.1.4 Examine data for trends
		6.1.5 Note particularly performance of paired subjects.
	6.2 Adjust procedures, if indicated	
7.0 Implement computer intervention for randomly selected remaining one-half of subjects (Phase II)	7.1 Run computer intervention with alternate paired subjects.	7.1.1 Same as 4.3.1 (i.e. 20 sessions within 8 weeks, with an average of 3 sessions per week)
8.0 Re-asses all subjects at completion of project.	8.1 Communication assessments	8.1.1 Same as 5.1.1 8.1.2 Same as 5.1.2
	8.2 Parent and teacher interviews	8.2.1 Same as 5.2.1 8.2.2 Same as 5.2.2 8.2.3 Same as 5.2.3
	8.3 Behavioral observation in classroom	8.3.1 Same as 3.3.1
9.0 Complete data analysis of Phase II intervention and total project	9.1 Data analysis of Phase II intervention	9.1.1 Same as 6.1.1 9.1.2 Same as 6.1.2 9.1.3 Same as 6.1.3 9.1.4 Same as 6.1.4 9.1.5 Same as 6.1.5
	9.2 Data analysis of total project	9.2.1 Summarize and compare data analysis from 6.1.1 - 6.1.5 and 9.1.1 - 9.1.5
10.0 Complete follow up testing	10.1 Re-test subjects on criterion referenced vocabulary two months after end of project	10.1.1 Administer vocabulary test 10.1.2 Score and compare with performance on prior testing.
11.0 Complete final report	11.1 Summarize statistical trends	
	11.2 Summarize recommendations	

Objective	Major Activities	Tasks
	11.3 Present summary to County Office and participating sites for comments and review	
	11.4 Revise and complete final report	
12.0 Conduct dissemination activities appropriate to project outcomes	12.1 Make national presentations	12.1.1 Identify appropriate professional organizations and their convention dates.
		12.1.2 Prepare presentation proposals and submit by designated deadline
		12.1.3 Prepare presentation
		12.1.4 Attend convention
	12.2 Make local presentations	12.2.1 Identify appropriate state and local organizations and their convention/meeting schedule
		12.2.2 Prepare presentation proposals
		12.2.3 Make presentations
	12.3 Write articles describing results of project	12.3.1 Identify appropriate journal publications
		12.3.2 Write articles and submit for review and possible publication
	12.4 Identify further research needed	12.4.1 Consider implications of research data
		12.4.2 Literature review
		12.4.3 Confer with project consultants
	12.5 Apply for model training grant	12.5.1 Identify appropriate funding sources and deadlines
		12.5.2 Write and submit grant

Table 2: Subject Description by Treatment Phase

	Phase I	Phase II
	N = 28	N = 24
Chronological Age (in months)		
	$\bar{x}$ = 69.9	$\bar{x}$ = 73.2
Developmental Age (Ordinal Scale, in months)		
	$\bar{x}$ = 24.9	$\bar{x}$ = 24.1
Diagnostic Category (N)		
Down Syndrome	3	5
Unspec. Retardation	8	9
Spec. Lang. Disorder	6	4
Severe Emtl Disorder	6	4
Multiple Handicaps	5	1
Cerebral Palsy	0	1
Secondary Handicap		
None	14	14
Mild cerebral palsy	8	3
Emotional overlay	3	1
Seizures	2	1
Visual problem	1	1
Mild hearing loss	0	4
Total minutes seen over 16 sessions		
	$\bar{x}$ = 368.9	$\bar{x}$ = 352.3

Note: None of the values is significantly different using t-tests.

Table 3: Dependent Variables for Communication-Related Outcomes (measures given to all Ss at pretest, midpoint and posttest)

Administered Directly by Researchers:

Peabody Picture Vocabulary Test-Revised
(American Guidance Service, 1981)
Expressive One-Word Picture Vocabulary Test
(Stoelting, 1984)
PEAL Criterion-Related Mastery Test
(unpublished)

Obtained through Parent Interviews:

Vineland Adaptive Behavior Scales, Survey Form
Communication
Socialization
(American Guidance Service, 1984)

Administered by Classroom Teacher:

Vineland Adaptive Behavior Scales, Classroom Edition
Interpersonal Relationships

Brigance Inventory of Learning Skills -Level 1
Prespeech Behaviors
Speech and Language
General Knowledge

Table 4: Composite Variables Used as Outcome Measures

Criterion Training Vocabulary

Sum of raw scores earned on levels 1 and 2 of the PEAL Criterion Related Mastery Test

General Language Skills

Peabody Picture Vocabulary Test
Expressive One-Word Vocabulary Test
Vineland Communication
Brigance Prespeech
Brigance Speech & Language
Brigance General Knowledge

Social/Interpersonal Skills
Vineland Socialization (parent)
Vineland Interpersonal (classroom ed.)

Table 5: ANCOVA Results for Two Training Phases on Three Composite Outcome Variables

PEAL Criterion Mastery Vocabulary Test:

	Baseline	Midpoint*	Posttest	Follow-up
Group A	10.77	23.09	22.23	23.02
Group B	14.25	16.67	25.17	23.02

*$F(1, 49) = 36.90$ $p < .001$

Differences between the groups at pretest were significant at $p < .10$ level in favor of the control group (B). Differences between the groups at posttest and follow-up were non-significant

General Language Skills Composite Variable:

Group A	157.31	184.34	201.32
Group B	155.16	167.11	186.12

*$F(1, 48) = 3.42$ $p < .10$

Differences between groups at pretest and posttest were non-significant

Social Interpersonal Composite Variable:

Group A	24.39	28.51	31.72
Group B	23.71	25.03	30.70

*$F(1,48) = 3.95$ $p < .10$

Differences between groups at pretest and posttest were non-significant